

On the results of Surveys in 1876-7 made for the purpose of Rectifying the System of Rail Road and Oil Well Levels throughout North West Pennsylvania.

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No attempt has heretofore been made to compare and adjust the levels of the numerous lines of Rail Roads interlacing the Oil Regions; consequently considerable misapprehension exists, not only as to the true ocean levels, but also as to the relative levels of many places frequently quoted and taken as points from which to calculate the fall of the surface and streams, or the dips of the oil rocks.

Within this district not one point of elevation has been *proven* to be correct. Harrisburg, Pittsburgh and the surface of Lake Erie are the nearest reliable points we have; and their true heights above mean ocean level have only recently been fixed through the well directed and successful efforts of Mr. Jas. T. Gardner, Geographer to the United States Geological and Geographical Survey of the Territories, under the charge of Dr. F. V. Hayden, United States Geologist.

These elevations above mean surface of the Atlantic Ocean—Harrisburg 320', Pittsburgh 745', and Lake Erie 573'—are now adopted; and from them we propose to carry forward the Rail Road lines of this district, to compare their intersections and junctions, and to fix and adopt certain points of elevation on which to base our geological work.

This, perhaps, should have been one of the first tasks of the Survey, but the material for it could not at that time have been immediately obtained; for even now after working towards the point for three years, much is wanting to make the adjustment as complete as could be wished.

The road most closely connected with the work of this district, is the Pittsburgh, Titusville and Buffalo Railway. It passes through the heart of the Oil Regions, along the valleys of the Allegheny River and Oil Creek from Pittsburgh to Corry and thence over the "divide" to Brockton. Unfortunately, its levels have been very unreliable; not so much, as we discover, now, from inaccuracy in the original instrumental work, as from a want of care in adjusting the datum planes of the several roads composing the present continuous line, to ocean level.

The elevation of Oil City, based on these levels has been variously given from 995' to 1049' above tide.* Other places along the line have varied in the same manner, but not to so great a degree.† There was also a want of agreement with the railways intersecting it, at the West Pennsylvania

* Meaning mean *high* tide at Philadelphia, Pennsylvania Rail Road datum; mean *tide* at Baltimore; mean *tide* at New York (Via Lake Erie), &c.

† Except at points like Driftwood on the Philadelphia and Erie Rail Road.

Rail Road Junction ; at Red Bank ; at Parker's ; at Oil City ; and at Corry. In 1875 the engineers in charge of the A. V. R. R. re-leveled its track from Kittanning up to South Oil City, but their work was based on the Kittanning bench-mark, the true elevation of which was in doubt. So that previous to the commencement of these examinations and our adjustment of the levels, we had not been able to secure a single elevation along the A. V. R. R. on which it seemed safe to rely.

As the shortest way out of these difficulties, and to establish some reliable base for the use of the survey, a re-leveling of the road, as far as might be necessary was resolved upon. Accordingly, early in February 1877, Mr. John H. Carl and Mr. Arthur Hale, provided with a superior rail road level and staff, proceeded to Pittsburgh to commence the work.

Every facility was afforded by the Chief Engineer of the Railway, Mr. H. Blackstone, to whom our thanks are due for these courtesies, for the examination of profiles and note books, and all the data of use secured from the office of the Rail Road Company.

Our levels were commenced at the Union Depot bench-mark and carried forward continuously to the old Kittanning bench-mark. A table comparing the results with a Railway profile, is appended. It shows a difference of only $\frac{2}{1000}$ of a foot between the Railway profile elevation of the Kittanning bench-mark and our own ; and establishes the height of this bench at 809.94' above mean surface of the Atlantic Ocean.*

From Kittanning to South Oil City there is a rise of 299.20' according to the Rail Road levels of 1875. But in a table of elevations furnished the Smithsonian Institution by the engineer of the road shortly after its completion, the difference between the same points is given as 298'. The levels of 1875, consequently, make the elevation of South Oil City 1009', the old levels 1008'.

From W. Pennsylvania Junction our re-leveling was carried on up the Butler Branch Rail Road, to Great Belt City. Here connection was made with our line run along the oil belt by Messrs. Hatch and Hale in 1875 and by Messrs. Chance and Hale in 1876. This last named line was then adjusted to the Pittsburgh datum, traced back to Parker's depot and found to coincide there within $\frac{1}{10}$ of a foot with the Allegheny Valley Rail Road, corrected elevation—thus showing a very reliable circuit from Allegheny Junction to Great Belt, from Great Belt to Parker's and from Parker's back to Allegheny Junction. So far the levels appear to be satisfactory.

From Parker's to Oil City, the following check was kindly furnished by Mr. D. Jones Lucas, Resident Engineer of the Union Pipe Company. Mr. Lucas ran a line of levels across the country in 1875 from Parker's depot to Oil City (Union Depot), and found the difference in elevation to be 118.9'. This added to our accepted elevation of Parker's 889', gives 1008' as the proper height of Oil City (U. Dep.) which is 0.45' lower than the South Oil City Depot.

* As established by United States Coast Survey in New York Harbor.

We now have these figures, using the decimals for Union Depot, Oil City.

By levels of 1875, Kitt. bench.....809.94 + 199.20 — 0.45 = 1008.69
 “ Old levels “ “809.94 + 198.00 — 0.45 = 1007.49
 “ Mr. Lucas, Parker’s Depot.....889.4 + 118.90 = 1008.30

It seems safe therefore to accept 1008’ as the established elevation of this point.

Our levels thus adjusted to Oil City, the next step was to connect the termini of the several Railroads centering there, with the Union Depot. When this was done the following rather discouraging results appeared :

Union Depot accepted elevation.....	1008’
“ “ by levels of O. C. & A. R. R.....	995’
“ “ “ “ “ A. & G. W. R.....	1007’
“ “ “ “ “ L. S. & M. S. R.....	1011’

The O. C. & A. R. levels appear to agree with the P. & E. and were supposed to be based on the P. R. R. datum at Philadelphia, which required an addition of 7’ to reduce it to ocean and make it conform to Lake Erie at 573’ above ocean. The A. & G. W. and L. S. & M. S. levels came in direct from Lake Erie. There was evidently some error between Oil City and the Lake if our accepted elevation of the Union Depot was correct. We endeavored to find it by connecting together the several Depots and benchmarks obtained from the railroad profiles, at Franklin, Irvineton, Corry, Union City and Erie, but did not succeed, and finally as a last resort, re-leveled the P. & E. R. R. from Union City to its junction with the L. S. & M. S. at Erie, and to the Lake.

To our surprise, the profile of the P. & E., which had been considered unreliable, was found to be remarkably correct, except as to ocean datum. The stations checked closely in every case, except in one or two instances where no doubt there had been an alteration of track, and the difference of elevation between Union City and the crossing at Erie as given by it and as ascertained by our levels varied only 0.08’.

By connecting the P. & E. Depot at Union City with the A. & G. W. Depot at the same place it was found that these two roads gave precisely the same fall from Cory crossing to Union, so that it was not deemed necessary to re-level that part of the P. & E. Rail Road.

From the Erie crossing above mentioned, connection was made with the L. S. & M. S. Depot at Erie, and, also, a line was run direct to the Lake. The line to the Lake confirmed the elevation given by the L. S. & M. S. R. R. for the Depot at Erie. It showed about six inches less elevation, but this is probably due to full water in the lake at this season of the year.

The P. & E. levels may therefore be considered as well tested and checked from the lake to Corry crossing, and they establish the latter point as will be seen further on at 1427’ above ocean (at New York).

When we inquire into the reason why 1416’ was given on the old P. &

E. profile as the elevation of the old Corry depot, and A. & G. W. crossing, instead of 1427 as it should be; we find that the levels of this end of the road, as far east as Warren (how much farther we do not know) were run from the Lake. They were based on lake level at 565', the accepted elevation of the lake at the date of that Survey, and were consequently 8' too low. In addition to this there seems to have been an error in placing the old P. & E. Lake Depot 8' above the surface of the Lake. It should have been 11' as the levels now show. It appears quite probable that this 3' error in starting at the lake was discovered and corrected in some of the engineers' notes, for I have a copy of the levels from Irvineton, west, procured from the Smithsonian Institution in which the Stations are all raised 3' above Burgin's profile. This 3' error added to the 8' difference between former and present accepted lake level, makes the 11' which we are obliged to add to raise the road to its proper height above the ocean and to place it in its true horizon to meet the levels brought up from Pittsburgh.

The first elevation given on the P. & E. profile as published (crossing of the L. S. & M. S. R. R.) shows very plainly that there is an error of 11' between that point and the Lake thus :

L. S. & M. S. crossing by P. & E. profile (VIII)	=	676
“ “ “ “ L. S. & M. S. profile (XI)	=	687
“ “ “ “ Carlil's levels to lake	=	687

As the levels and checks above mentioned appear to establish the correctness of the P. & E. profile from the Erie crossing to Corry we see no reason to doubt its integrity as far as the same parties carried forward their line, which we are informed by one who assisted in the Survey, was as far as Warren. We therefore propose to raise all the stations between the Lake and Warren 11'.

We now find that the Union and Titusville or O. C. & A. R. R. R. (a) must be raised 13' at Union City above the published levels to lift it to the P. & E. at that place, and 13' also at the other end at Irvineton to make it coincide there with the P. & E. This brings Oil City up also and makes it agree ($995' + 13' = 1008'$) with our accepted elevation, as will be shown further on.

Another interesting fact is brought to light by this discussion. The levels of the O. C. & A. R. R. were run from a datum given in the field book as "Elevation of track on bridge east of Irvineton Station on P. & E. R. R. above tide water at west end of Market Street bridge at Philadelphia = 1160."

This is, no doubt, the point given by Burgin as "Irvine 1162" and it explains why (having started 2' too low) the O. C. & A. R. R. requires to be raised 13', while the P. & E. is only raised 11'. It also shows that the O. C. & A. R. R. datum was not the P. R. R. datum as supposed, but ocean datum, based on Lake Erie at 565', subject to the same error of 11' as the P. & E. with the additional 2' made in the starting point at the bridge.

(a) The U. & T. is now a branch of the O. C. & A. R. R. R.

The two tables of the P. & E. levels (the Company's and Burgin's) given by Mr. Allen, in his R. R. levels of Pennsylvania, contain in themselves the evidences of inaccuracy. The Company's profile datum is "Mid tide Baltimore." Burgin's is P. R. R. datum on the east end and Lake Erie based on ocean on the west end (but now shown to be 11' too low), yet both profiles give the same elevation at Corry crossing and I believe run exactly together from Corry to the lake, if they could be compared at precisely the same points. They seem both to have been made from one line of levels. Where the error in joining the line run from the east with the line run from the west may have occurred we do not know,* but certain it is that no "P. R. R. datum" or "mid tide Baltimore datum" levels have been correctly brought through to Irvineton.

Mr. Gardner in his discussion of R. R. levels to establish the surface elevation of Lake Erie, says, Lake Erie is above Harrisburg by P. & E. levels 251'; this added to the height of Harrisburg, 319.75' = Lake Erie 570.75'. If the levels of this road were run from Harrisburg west, and from the Lake east, it is perceived at once that the P. & E. levels had nothing whatever to do with the difference of elevation between Harrisburg and the Lake. It was only the difference between 314', the starting point at Harrisburg as given by Burgin and 565' the starting point at Erie. The Harrisburg end was raised 5.75' to bring it up to correct ocean level, the Lake end 8' to bring it up to accepted lake level, consequently the line showed an error of 2.25 making Lake Erie, 570.75' instead of 573'. Of course it was supposed that the levels were corrected throughout, but they could not have been correctly connected in fact, for we shall show that while the western end requires to be lifted 11' the centre needs to be raised from 19' to 23'.

We have met this same trouble in other roads in this district, where they have been run from one known, or supposed to be known, elevation to another. They agree at each end with the points given, but our cross checks lead to the suspicion that it has required some adjustment and alteration of the levels actually obtained to make them do so.

The re-leveling of the P. & E. R. R. and the corroborative circumstances above given should establish the correctness of our Union City adopted elevation of 1270' and our Corry adopted elevation of 1427' at the crossing of the P. & E. and A. & G. W. Railways almost beyond a question. They cannot vary more than the fraction of a foot from the figures here given. They also furnish the data from which to adjust the levels of the O. C. & A. R. and Union & Titusville Railways leading from the P. & E. to Oil City as will be seen below.

Absolute accuracy is not of course to be expected in an adjustment of this kind, where the levels of different roads are to be tied together and com-

* It seems quite probable, we think, that the error will be found between West Creek Summit near St. Mary's and Clarion Summit near Kane. In that case West Creek Summit should be raised 19' to correspond with Emporium, and all stations between Kane and Warren 11' to correspond with the Lake end of the line.

pared. Slight errors necessarily creep into every profile—by the change in engineers employed ; and consequent mistakes in benches and level points, which often are not plainly marked or described in the notes as they should be ; by local alterations of track or change in position of depots not always carefully noted ; by alterations at junctions and crossings made by one road and not recorded by the other ; and by clerical errors in copying and working up the notes and profiles.

In making these adjustments considerable time has been spent in the field in ascertaining the relation levels of depots, crossings, benches &c. At Pittsburgh, Allegheny City, Freeport, Parker's, Franklin, Oil City, Irvineton, Titusville, Corry, Union City, Erie City, Girard and other places, and in every case more or less variation has been found, relatively, in the points given—comparing them as they now are and as they were when originally established. These sources of error cannot now be eliminated without a careful re-leveling of the railway lines, which manifestly is an impossibility under the circumstances. It only remains for us to make the best practical use we can of the materials at command. As we have shown that they are somewhat defective it would be folly to pretend to work out these hypsometric elevations to the decimal part of a foot. We shall not attempt it but aim only to establish the levels of some of the more important points in this district within a foot or two of the truth which is near enough for all practical purposes.

A

The first line considered will be from Pittsburgh to Lake Erie by the Allegheny Valley, Bennett's Branch, Philadelphia & Erie, and Buffalo, N. Y & Erie Railways.

			Above ocean.
Pittsburg U. Depot.		Accepted elevation	745
Red Bank Junct.	106	Above Pittsburgh by A. V. profile (I)	851
" "	832	" ocean by Bennett's Branch " (IV)	
" "	19	Too low on " " " "	
Driftwood June.	37	Below Red bank Junct. by B. Branch profile (IV)	814
" "	795	Above ocean by P. & E. profile (Note to IV)	
" "	19	Too low on P. & E. profile	
Emporium June	208	Above Driftwood June. by P. & E. profile (Allen CCXV)	1022
" "	1003	Above ocean by P. & E. profile (do.)	
" "	1021	" " B. N. Y. & P. " (XVII)	
" "	19	Too Low on P. & E. " "	
" "	1	" " B. N. Y. & P. " "	
Olean Crossing	414	Above Emp. Junct. by B. N. Y. & P. profile (XVII)	1136
" "	1438	Above ocean by N. Y. & Erie profile (Jersey City datum)	
" "	1435	Above ocean by B. N. Y. & P. " "	
" "	2	Too high on N. Y. & Erie " "	
" "	1	" low " " " "	
Lake Erie	862	Below Olean Crossing by B. N. Y. & P. profile (XVII)	
" "	861	Below Olean Crossing by N. Y. & Erie profile (XVIII)	
" "	863	Below Olean—mean of the above levels.	573

This line it will be noted lifts all the levels from Red Bank Junction to

Emporium Junction 19 feet, and the B. N. Y. & Philadelphia levels 1' as far as Olean. It crosses the N. Y. & Erie Railway at Olean two feet below the Erie levels, which were run from tide at Jersey City and would reach the Lake one foot too high if carried down by the B. N. Y. & Philadelphia levels, which gives 862' fall. But we find that the N. Y. & Erie levels give 864' fall so that a mean between the two, 863' subtracted from 1436' = 573' the precise elevation as accepted for Lake Erie. The B. N. Y. & Philadelphia levels are said to have been run from the water of Buffalo Creek some distance from the lake and may therefore be presumed to be based on a higher point than lake level.

Variations of from one to three feet will be found between different lines at nearly every point we are attempting to compare. As we are only rising even feet in making this adjustment, a disagreement of one foot may sometimes occur in this way between two roads where there would really be but a very slight difference if the decimals were accurately taken into account.

B.

Pittsburgh to Lake Erie by the Allegheny Valley, Oil Creek, and Allegheny River, Union and Titusville and Philadelphia and Erie Railways.

			Above ocean.
Pittsburgh		Accepted elevation	745
Oil City U. Depot	263	Above Pittsburgh by A. Valley profile (I)	1008
" "	995	Above ocean by O. C. & A. R. profile (VI)	
" "	1007	Above ocean by A. & G. W. profile (X)	
" "	1011	" " " L. S. & M. S. " (XII)	
" "	13	Too low on O. C. & A. R. profile	
" "	1	" " A. & G. W. "	
" "	3	Too high on L. S. & M. S. "	
Titusville	186	Above Oil City by O. C. & A. R. profile (VI)	1194
"	1181	Above ocean by O. C. & A. R. profile (VI)	
"	1181	Above ocean by U. & T. profile (VII)	
"	13	Too low on O. C. & A. R. "	
"	13	" " U. & T. "	
Union City P. & E. Depot		Accepted elevation established by levels from the lake	1270
" " "	177	Above Titusville by U. & T. profile (VII) (1271)	
" " " "	1258	Above ocean by U. & T. profile (VIII)	
" " " "	1259	" " P. & E. " (VIII)	
" " " "	12	Too low on U. & T. "	
" " " "	11	" " P. & E. "	
Erie City			
L. S. & M. S. & P. & E. Cross'g.	583	Below Union City by P. & E. profile (VIII)	687
" " " "	583	Below Union City by levels run by J. H. Carl	687
" " " "	676	Above ocean by P. & E. profile (VIII)	
" " " "	11	Too low on "	
Erie City			
L. S. & M. S. Depot	0.72	Below Erie Crossing (Carl's levels)	686
" " "		Above ocean by L. S. & M. S. profile (XI)	686
" " "	113	Above lake by L. S. & M. S. profile (XI)	
" " "	113	" " Carl's levels	
Lake Erie		As above 686-113	573

This determination shows a very satisfactory line of levels from Pitts-

burgh to the Lake by raising the O. C. & A. R. and Union & Titusville Railways 13 feet and the P. & E. Railway 11 feet and by throwing off all the decimals on the Allegheny slope and making the most of them on the Lake slope. But even by doing this there is still an error of one foot to be accounted for at Union City which is referred to more fully in remarks following determination C.

Mr. Gardner in summing up his conclusions on the elevation of Pittsburgh says he is inclined to accept 746 in preference to 745 for the elevation of the Union Depot. But the levels of the Railroads leading to the Lake through this district conform better to the height we have adopted, 745, and might even seem to suggest a lower level for Pittsburgh.

C.

Oil City to Lake Erie, by the Oil Creek and Allegheny River Railway to Irvineton and the P. & E. Railway from Irvineton to the Lake—using Burgin's profile of the P. & E. Railway.

			Above ocean.
Oil City		Accepted elevation	1008
Irvineton Bridge, . . .	165	Above Oil City by O. C. & A. R. profile (VI)	1173
" " . . .	1162	" " ocean by P. & E. " (VII)	
" " . . .	1160	" " " O. C. & A. R. " (VI)	
" " . . .	11	Too low on P. & E. "	
" " . . .	13	" " " O. C. & A. R. "	
Corry Crossing			
A. & G. W. & P. & E.	254	Above Irvineton by P. & E. profile (VIII)	1427
" " . . .	1416	" " ocean " " " (IX)	
" " . . .	1429	" " " A. & G. W. " " (VI)	
" " . . .	1418	" " " O. C. & A. R. " " "	
" " . . .	11	Too low on P. & E. "	
" " . . .	9	" " " O. C. & A. R. "	
" " . . .	2	Too high on A. & G. W. "	
A. & G. W. Depot			
Union City	128	Below Corry by A. & G. W. profile (IX)	1299
" " . . .	1301	Above ocean " " " "	
" " . . .	2	Too high on " " " "	
P. & E. Depot			
Union City	20.22	Below A. & W. Depot, Union City (Carll)	1270
" "	157	" " Corry crossing by P. & E. profile (VIII)	1270
" "	1259	Above ocean " " " "	
" "	11	Too low on " " " "	
L. S. & M. S. & P. & E.			
Erie Crossing.	583	Below Union City by P. & E. profile (VIII)	687
" " . . .	583	" " " " Carl's levels	687
" " . . .	114	Above Lake Erie by L. S. & M. S. profile & Carll (XI)	687
" " . . .	676	Above ocean by P. & E. profile	
" " . . .	11	Too low on " " " "	
Lake Erie.	114	Below P. & E. & L. S. & M. S. crossing as above	573

The levels of the Dunkirk Allegheny Valley and Pittsburgh R. R. touching the P. & E. at Irvineton, are so widely astray and evidently unreliable as heretofore published that we can make no use of them in this connection to reach the Lake. A trip to Dunkirk expressly for the purpose of examining the profiles with a view of including the levels of the road in this discussion resulted unsuccessfully, for the want of a permit from headquarters in New York and we are obliged to omit them altogether.

So too, unfortunately with the Buffalo Corry & Pittsburgh Railway

crossing the P. & E. at Corry, which would have given another link to the Lake at Brocton. The published levels are so vague and uncertain that we must omit them also. Mr. Ashmead kindly permitted and assisted in a thorough search among the papers in his office at Oil City, but no profile or connected notes of the levels could be found.

If our accepted elevations of Irvineton, Corry, and Union City are correct, and we have every reason to believe that they are, it appears quite evident that there must be some mistake in the levels of the O. C. & A. R. and U. & T. Railways, otherwise they would agree with our accepted elevations if raised uniformly 13' at all points, instead of 13' at Irvineton, 9' at Corry and 12' at Union City. They start as we have shown at an elevation of 1160' at Irvineton, which represents 1162' on the P. & E. profile, and running around by Oil City and Titusville reach Union City at 1257' which should represent 1259' on the P. & E. profile if all the levels were harmonious. From the published tables it would be inferred that the P. & E. Depot in the U. & T. tables was the same as the P. & E. depot in the P. & E. tables; but the U. & T. profile shows that the point 1257' was the junction with the P. & E. and this junction is 1.39' lower than the depot. There is therefore a disagreement of one foot or more between the two lines of levels from Irvineton to Union City, the P. & E. being about 34 miles in length and the O. C. & A. R. and U. & T. about 92 miles. This is not sufficient to cast doubt upon the main line of levels and we therefore accept them as correct as far as Tryonville Junction, presuming that the error lies somewhere quite near Union City, for we find our levels there between the crossings and Depots to differ quite materially from those given by the U. & T. profile as will be seen by reference to Union City levels.

We now have these three points apparently well established.

Tryonville Junction.....	1320'
Corry.....	1427'
Union City.....	1270'
Tryonville Junction is 111' below Corry by O. C. & A. R. (VI).	
“ “ 49' above Union City by U. & T. (VII).	

Then calculating the elevation of Tryonville J. from Corry and Union City we have :

$$\begin{array}{l} \text{Tryonville by O. C. \& A. R. levels } 1427 - 111 = 1316 \\ \text{“ by U. \& T. “ } 1270 + 49 = 1319 \end{array}$$

The relative elevations of Corry and Union City are well assured by the exact agreement of the P. & E. and A. & G. W. levels between those places, and we therefore can only conclude that there is an error of one foot to be accounted for on the U. & T. profile between Tryonville Junct. and Union City, and an error of 4' on the O. C. & A. R. profile between Tryonville and Corry which we have been unable to place and must, therefore, leave for future adjustment.

D

Oil City to Ashtabula by Franklin Branch of Lake Shore and Michigan Southern Railway.

			Above ocean.
Oil City,		Accepted elevation	1008
Stoneboro' . . .	160	Above Oil City by L. S. & M. S. profile (XII)	1168
"	1171	" " ocean " " (XII)	
"	1171	" " by N. C. & F. " " (XIV)	
"	3	Too high on L. S. & M. S. " "	
"	3	" " N. C. & F. " "	
Salem Crossing,	184	Below Stoneboro' by L. S. & M. S. profile (XII)	984
" "	987	Above ocean " " (XII)	
" "	982	" " by A. & G. W. " " (IX)	
" "	3	Too high on L. S. & M. S. " "	
" "	2	" low " A. & G. W. " "	
Jamestown . . .	3	Above Salem Crossing by L. S. & M. S. profile (XII)	987
" "	990	" " ocean " " (XII)	
" "	979	" " E. & P. " " (XIII)	
" "	3	Too high on L. S. & M. S. " "	
" "	8	" low " E. & P. " " (a)	
Ashtabula . . .	342	Below Jamestown by L. S. & M. S. profile (XII)	645
"	648	Above ocean " " " "	
"	3	Too high on " " " " (b)	

(a) The two depots here are not on precisely the same level, but there certainly cannot be 11' difference in their elevations. The E. & P. appears to be wrong wherever we check it.

(b) These levels, according to profile, run into Ashtabula at the proper elevation (74.52) to agree with the levels of the main line which are accepted as correct. But it is hard to explain why the Franklin Branch overruns the A. & G. W. at Salem Crossing, at Franklin, at Reno, and at Oil City, while the same levels of the L. S. & M. S., taken at Erie Crossing and Carried to Union City by the P. & E. Railway, run under the A. & G. W. at that place. The P. & E. levels from Erie to Union City were re-run but no error could be discovered there. We have no ground for charging the whole mistake to the A. & G. W., for their levels, as will be seen in another place, bear every evidence of more than ordinary precision from Salamanca to Dayton. It would appear as if the Franklin Branch of the L. S. & M. S. had been started from a higher point than that given on the main line as 74.52. But this, of course, is an inference only and may be entirely wrong.

E

From Pittsburgh to Stoneboro' by Pittsburgh, Fort Wayne and Chicago to Homewood, New Castle and Beaver Valley to New Castle and Franklin to Stoneboro'.

			Above ocean.
Pittsburgh,		Accepted elevation	745
Homewood,	204	Above Pittsburgh by P. F. W. & C. profile (XVI)	949
New Castle,	147	Below Homewood by N. C. & B. V. " " (XV)	802
" "	809	Above ocean by E. & P. " " (XIII) (a)	
" "	7	Too high on " " " "	
Stoneboro',	368	Above N. Castle by N. C. & F. profile (XIV)	1170
"	160	" " O. City by L. S. & M. S. profile (XII) accepted (b)	1168
"	1171	" " ocean " " " "	
"	1171	" " N. C. & F. " " (XIV)	
"	2	Too high by levels brought from Pittsburgh	
"	3	" " on L. S. & M. S. profile	
"	3	" " N. C. & F. " "	

(a) It is supposed that the elevation here given by the E. & P. refers to a point somewhat higher than the present Depot.

(b) We prefer to accept 1168' as the elevation of Stoneboro' instead of 1170' or 1171' for several reasons. From Pittsburgh to Oil City by the line just followed we find a rise of 265', while from Pittsburgh direct to Oil City by the A. Valley Railway levels well tested we have a rise of 263'. There is an error of 2' somewhere in the circuit. The L. S. & M. S. levels are too high at Oil City when compared with the A. V., the O. C. & A. R. and the A. & G. W.; they are too high again at Franklin, compared with the A. V. and A. & G. W.; too high at Salem Crossing, compared with the A. & G. W.; and too high at Jamestown, compared with the E. & P. We are not certain that the connecting link between N. Castle and Stoneboro' shows precisely the difference in elevation between the Depot of the N. C. & B. V. at N. Castle and the Depot of the L. S. & M. S. at Stoneboro. There might easily be a difference of two feet between the Depots of the N. C. & F. and those of the other roads named. Our accepted level at Oil City appears to be a mean between the highest and lowest levels given wherever a check can be secured, and it therefore seems safe to adhere to it.

F

Review of the levels of the Atlantic and Great Western Railway.

		Above ocean
Salamanca . . .	1393	Above ocean by A. & G. W. profile (IX)
" . . .	1384	Point given as centre of Hemlock st.
" . . .	1384	Above ocean by N. Y. & Erie profile (XVIII)
Present Depot.	1.3	Supposed to be the old Depot
Old Depot. . . .	14.2	Lower than Hemlock St. (Carll)
Present Depot.	1392	Above ocean by A. & G. W. levels (1393-1)
" . . .	1397	N. Y. & Erie " (1384-13)
" . . .		Accepted elevation. 1393

The N. Y. & Erie, as before stated, reaches the Lake 2' too high, so that there appears to be but 3' disagreement between the levels of the A & G. W. and the N. Y. and Erie, if we have taken our points correctly, and 1393' will be a fair mean between the two for the present depot.

Levant, Accepted elevation as given by A. & G. W. (IX) 1267

The D. A. V. & P. Ry. coming up from the lake at Dunkirk crosses the A. & G. W. here. The elevation given by it is 1262 (Allen CCCVI), but it does not appear to be reliable.

Corry, A. & G. W. 2' too high as shown in C.

Union City, A. & G. W. 2' too high as shown in C.

Salem Crossing, A. & G. W. 2' too low as shown in D.

		Above ocean.
Clarkesville Crossing	46	Below Salem Crossing (D) = 984-46. 938
" . . .	936	Above ocean by A. & G. W. profile (IX)
" . . .	930	" " E. & P. " (XIII)
" . . .	2	Too low on A. & G. W. "
" . . .	8	" " E. & P. "

At Jamestown the E. & P. was 8' too low (D) by our accepted eleva-

tion and 11' too low by L. S. & M. S. levels, and here we find it 8' too low by our adjustment, and 6' if the A. & G. W. is correct—while at N. Castle (E) it is 7' too high. In the first and last places the difference may be in a measure due to a want of unity in the points given by the several roads, but until we have more positive information on these points the E. & P. levels must be regarded as very unreliable.

Further Checks on the A. & G. W. Railway, in Ohio :

			Above ocean.
Ravenna Cross'g.	522	Above Lake Erie by A. & G. W. profile (See Ohio Geological Report, Vol. I, p. 667).	1095
" "	519	Above Lake Erie by Cleveland & Pittsburgh profile (Authority J. Linton, Chief Engineer)	1092
	3	Disagreement.	
Newburg Cross'g.	175	Above Lake Erie by A. & G. W. profile (IX)	748
	174	" " " " (Linton)	747
	1	Disagreement.	
Gallion.	596	Above Lake Erie by A. & G. W. profile (O. R. I, p. 667).	1169
" "	595	" " " " C. C. C. & I. " (O. R. I, p. 668).	1168
	1	Disagreement.	
Urbana.	451	Above Lake Erie by A. & G. W. profile (O. R. I, p. 667).	1027
" "	458	" " " " S. D. & C. " (O. R. I, p. 671).	1031
	4	Disagreement, relative levels of depots unknown	
Dayton.	179	Above Lake Erie by A. & G. W. profile (O. R. I, p. 667).	752
" "	180	" " " " D. & M. " (O. R. I, p. 671).	753
	1	Disagreement.	

The Dayton & Michigan Railroad check is used by Mr. Gardner (page 644) and accepted as reliable.

G.

East end of the Philadelphia and Erie Railway, compared with the Northern Central.

			Above ocean.
P. R. R. Datum.			6,913
Harrisburg.	313	Above P. R. R. datum by P. R. R. profile (Allen I).	320
Bridgeport Cross'g	29	Above Harrisburg by P. R. R. profile (Allen I).	349
	30.25	" " " " by N. C. profile (Gardner, pp. 695)	350
Sunbury.		Above Ocean by N. C. profile (Allen CC)	414
" "	428	" " " " P. & E. " (Allen CCXV)	
" "	430	" " " " Burgin's " " " "	
	16	Too low on P. & E. profile.	
	14	" " " " Burgin's "	
W'msport Junct.		Above Ocean by N. C. profile (Allen CCXVII)	540
" "	516	" " " " P. & E. " (Allen CCXV)	
" " Depot	5.59	Below Junction by P. & E. profile (Allen CCXV)	
		On Northern Central bases (540-6)	
" "	510	Above ocean by P. & E. profile (Allen CCXV)	531
" "	513	" " " " by Burgin's " " " "	
" "	21	Too low on P. & E. profile.	
" "	21	" " " " Burgin's " " " "	
Elmira.		By N. C. profile (Allen CCXVII)	865
" "		By N. Y. & E. profile (Allen CLXII)	863

This last check makes the Northern Central levels appear good. The levels of the N. Y. and Erie Railway have been brought up from Jersey City, about 273 miles, and those of the Northern Central from Baltimore, 256 miles showing a disagreement of only two feet at Elmira. It seems quite safe, therefore to assume that the P. & E. elevations of Sunbury and Williamsport are altogether too low, as they have likewise been shown to be at Driftwood, Emporium, Irvineton, Corry, Union City and Erie.